LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Secondary Sexual Characters.

IN his article on "Antelopes and their Recognition Marks" in the number of NATURE dated October 11, Mr. R. I. Pocock suggests that the darker colour of the males in certain species is the outcome or accompaniment of "male katabolism." As generally used, this term seems to denote some peculiarity universally associated with the male sex and giving rise to male peculiarities, so that a character which is the outcome of male katabolism does not require to be explained by the theory of sexual or that of natural selection. This is the sense in which Geddes and Thomson use the term in their "Evolution of Sex": "So brilliancy of colour, exuberance of hair and feathers, activity of scent glands, and even the development of weapons, are not and cannot be explained by sexual selection, but in origin and continued development are outcrops of a male as opposed to a female constitution." But if male katabolism is always associated with the male sex, how is it that there are so many species in which there are no secondary differences between male and female, no outcrops of male katabolism? Either male katabolism, as something different from female katabolism, does *not* exist in the males of all species, or it sometimes exists without producing any visible effect.

It is therefore evident that male katabolism in the kinetic, and not merely the potential, state occurs only in the males of those species which exhibit sexual dimorphism. After all, katabolism is only a name for certain phases of physiological activity, and we thus arrive at the hypothesis that male sexual peculiarities are the result of the peculiar katabolism of the males that possess them. Now we have a reason for such peculiar katabolism, or metabolism, in the special nervous and muscular activity which is observed in the sexual habits of those males which possess secondary sexual characters. This excitement and muscular exertion involves an increase of the metabolism, which goes far to explain, among other things, an increased production of pigment, and the consequent darker or more intense colouring of the males in many instances. The special metabolism is thus due to the habits of life, to external conditions, not to any quality necessarily associated with male sexuality.

It seems to me that, regarding the subject from the point of view I have indicated, we may arrive at the explanation of the darker colour of certain male antelopes, and also of the presence of horns in the males only. If the peculiarities of the male, in particular its colour, are thus the necessary results of physiological processes, they are sufficiently explained, without the additional suggestion that the hornless female has been compelled to adhere to the normal protective colouring of the group, while the males, by reason of their horns and superior strength, have been able to dispense with that advantage. Moreover, Mr. Pocock maintains, in other cases in which horns are developed in the male only, that the markings of the male are protective, for instance, in the kudu. J. T. CUNNINGHAM.

Penzance, October 27.

The Value of the Cylinder Function of the Second Kind for Small Arguments.

IN investigating the propagation of electrical oscillations along cylindrical conductors, the "K_0" function, which satisfies the Bessel's equation and vanishes at infinity, is used to express the vectors outside the wire. Under the conditions of the problem the approximate value of this function for very small arguments is needed. I wish to point out an error in this value, which occurs in all three important memoirs in which the subject has been discussed—viz. those of Prof. J. J. Thomson ("Recent Researches," p. 263), Sommerfeld (*Wied. Ann.*, lxvii. p. 245, 1899) and Mie (*Ann. d. Physik*, ii. p. 211, 1900), an error which can, I think, be traced to a misprint in Heine's "Kugelfunctionen."

The formula given by Heine (vol. i. p. 245) yields as the approximate value $K_0(x) = \log \frac{2}{x} - C + \frac{1}{2}\pi i$.

C is Euler's constant 0·5772 . . . but in the statement of its value which follows – C is printed for C. This mistake, which is not corrected in the errata, is pointed out in the "Treatise" of Gray and Mathews (p. 88, footnote).

If we put $e^{\gamma} = {}^{\cdot}5772$, we have $K_0(x) = \log \frac{2i}{\gamma x}$. In the papers referred to, the γ appears in the numerator, which would correspond to the alteration in the sign of C. In Prof. Thomson's work the i in the numerator is omitted.

The error has no effect on the theoretical conclusions reached in the papers. The numerical results given by Sommerfeld and Mie are subject to corrections, which will not, however, affect the order of magnitude. For example, the attenuation constants worked out by Sommerfeld are something like 10 per cent. too small. W. B. MORTON.

Queen's College, Belfast, October 25.

Mosquitoes and Diseases.

AT p. 627 of your issue of October 25, while noticing Profs. Grassi and Noè's observations on *Filaria immitis*, you say "Malaria is not the only disease which is propagated by mosquitoes." May I remind your readers of Dr. Patrick Manson's important observations on *Filaria sanguinis-hominis*, originally communicated to the Linnean Society by Dr. Cobbold, on March 7, 1878 ("On the Development of *Filaria sanguinis-hominis*, and on the Mosquito considered as a Nurse": *Journ. Linn. Soc. Zool.*, xiv., pp. 304–311), and amplified later in a paper communicated on March 6, 1884 ("The Metamorphosis of *Filaria sanguinis-hominis* in the Mosquito": *Trans. Linn. Soc. Zool.*, ser. 2, vol. ii., pp. 367–388, pl. xxxix.)? W. F. KIRBY.

British Museum (Natural History), London, S.W., October 30.

OUR STELLAR SYSTEM.

IN a recently published volume[1] I endeavoured to bring together the facts relating not only to the distribution of stars generally, but to those which the spectroscope has more recently brought before us touching the distribution of the various chemical groups of stars. One of the interesting results of the inquiry was that the Milky Way, which dominates the general distribution, is also the region of the heavens in which undoubted nebulæ giving us bright-line spectra most do congregate. Nor is this all. Those so-called "stars," in the spectra of which bright lines are seen, "bright-line stars" and "new stars," which I have elsewhere shown are nebulæ or stars associated with nebulæ, are also almost entirely confined to the Milky Way. The new spectroscopic knowledge, although so priceless to the student of the chemistry of space, tells us, however, nothing as to the distances of the bodies from us; it only tells us that they lie in the galactic plane. If, however, we combine with the chemical facts the results obtained by Monck, Kapteyn and others touching the proper motions of the various kinds of stars as defined by their spectra, the results we obtain are most definite.

Dealing with the stars generally, it may be stated that the latest inquiries have suggested the following very general classification of stars depending upon temperature:—

Highest Temperature.

Gaseous stars { Proto-hydrogen stars.
Cleveite-gas stars.
Proto-metallic stars.
Metallic stars.
Stars with fluted spectra.

Lowest Temperature.

Now to make the most general statement, we find that the gaseous stars are not only confined to the Milky Way, but they are the most remote in every direction, in every galactic longitude; all of them have the smallest proper motion. The metallic stars are nearest to us, but they are *not* confined to the Milky Way. The proto-metallic stars are intermediate between these two great groups,

[1] "Inorganic Evolution," pp. 124–143.

both in regard to their proper motion and their distribution.

Now the spectroscopic similarity between the gaseous stars and the "bright-line" and "new" stars, and the planetary nebulæ, justifies our assuming provisionally that they exist under some similar conditions, and, as they are all confined to the Milky Way, we are further justified in assuming that they lie at the same distance from us.

The smaller proper motion of the hottest stars, in which I include the bright-line stars, proves that the region which gives rise to them as well as the new stars, and the planetary nebulæ, is far away *on all sides*. If it were not so we should get a very small proper motion in one direction and a very large proper motion in another.

But the stars in question in the Milky Way, which is a great circle, are all equally remote; and the only place whence such a state of things can be observed must be a point equally distant from all, that is, in the centre of the system under observation.

It is worth while to repeat that it is because we are in the centre, because the solar system is in the centre, that the observed effect arises, and if we imagine the solar system very far from the centre we should get very different proper motion conditions on this side and on that; but seeing that we have found that we get the smallest proper motion with regard to all the hottest phenomena that we know of in space, we have to consider that the still truly nebulous region is far away from us in every direction, and that it practically is limited to the plane of the Milky Way.

Photographs of some drawings made by Herschel, when he was first brought into the presence of the wonderful nebulæ with which the heavens are peopled, will give an idea of what possibly may be the condition of things touching our own system. We have amongst them drawings of "globular" nebulæ, possibly not globes, but systems looked down upon from their poles, and the possibility of that arises from the fact that many nebulæ are looked at edge-ways, and are very thin. Hence we do not know that the apparently globular clusters are not really those things looked at from the poles of their movement. We have not only those globular and elliptic nebulæ, but we have double elliptic nebulæ, which might be considered as explaining how the Milky Way happens somehow or another to be doubled. In addition to these we have well-defined ring nebulæ, the best example of which is in the constellation Lyra. It has been often imagined, up to now, by those who have considered this subject, that the Milky Way owes its appearance to the fact that there is really a spiral nebula in question, and that the stars which form the stellar system and form the companions of the sun exist at the centre of a spiral nebula. One of these spiral nebulæ, which we observe looking down on the whole system from the pole is the spiral nebula in Canes Venatici. The wonderful nebula in Andromeda, also a spiral nebula, we look at side-ways, and so it appears elliptical, and in this we notice that the greatest condensation is in the centre. But we know, from what I have stated, that our greatest condensation is not in the centre; in our case the greatest vacuity is in the centre. We are in the quiet, in the centre; so that certainly if we take our choice of these different forms, we must say that our system is much more like that of the ring nebula in Lyra than it is to such systems as those in Canes Venatici and Andromeda. We, according to Gould's work, have in the centre of our system, represented by the Milky Way, a small number of cooling stars all congregating together; outside that at an infinite distance from these relatively cool bodies, we have the Milky Way stretching with all its concomitants of gaseous stars, planetary nebulæ, bright-line stars, new stars, and so on. We must therefore consider that in our present knowledge such a condition of things as is represented by the ring nebula in Lyra fits our facts very much better than the condition which is represented by such a spiral structure as Andromeda, in which the greatest heat—I say that because there is obviously the greatest luminosity—is located at the centre. I have already referred to the proper motion evidence. It is obvious that in the case of the nebula of Andromeda, if we imagine an observer at the centre, large, medium, and small proper motions would be observed in every direction in the plane of the system, for the reason that the spirals lie in some cases near to, and in others far from, the centre, and that there are many spirals. We practically know that in our system the centre is the region of least disturbance, and therefore cooler conditions.

I now come to another point which must be considered in the next place.

Let us assume for the moment that the average brightness of stars depends upon their distance; then the

FIG. 1.—Spiral nebula of Canes Venatici, from a photograph by Dr. Roberts.

number of stars of a given magnitude indicates the stellar density at a corresponding distance. Gould from actual enumeration has given a formula which shows us that if the stars were uniformly scattered in space, and the light from them suffered no extinction in coming to us—if it did not meet anything that it could not get through—then the number of stars visible to us through a telescope, such as we have at Kensington or at Mount Hamilton, should be about 12,000,000,000. But the number actually visible, so far as counts are concerned, is certainly very much less, and, in fact, it has been estimated that the countable number, instead of being 12,000,000,000, is only about 100,000,000. This estimate seems to me very low, but I am bound to give it. When we come to consider the stars of different magnitudes in different parts of

space, we find a very great difference in relation to the plane of the Milky Way; but irrespective of this it may be said that omitting some 500 of the brighter stars, which have to be classed separately, up to the 9th magnitude, the actual and theoretical numbers are fairly accordant, but there is a distinct indication of a thinning out of stars after the 9th magnitude is passed. An example of this has been furnished by Prof. Pickering, who has given us a very useful diagram of the brightness of the stars seen within 1° from the celestial pole: that is to say, a region about 28° from the Milky Way. There is a very considerable number of stars of the 9th and 10th magnitudes, but very few of the 14th and 15th. In that way it is possible to investigate the conditioning of stars with regard to their brilliancy in the Milky Way itself; the value of the diagram now given is that it shows what happens in a position away from the plane.

FIG. 2.—The great nebula in Andromeda, from a photograph by Dr. Roberts.

There is one other point which arises which is well worth our attention. It is a subject that we have to approach with caution, because it is such a large one, and because so little is known about it. When we look away from the plane of the Milky Way to the poles, we find, as the late Mr. Waters very conclusively proved to us by his tabulations, the greatest number of so-called nebulæ; it is very difficult to discuss this matter, because the nature of these nebulæ is undefined, we are without any information as to whether they are gaseous nebulæ or non-gaseous, and we may burn our fingers by talking about them. If, however, we consider the matter from the point of view at which we have now arrived from the complete discussion which is open to us, the question arises whether this enormous increase of nebulæ towards the poles of the Milky Way

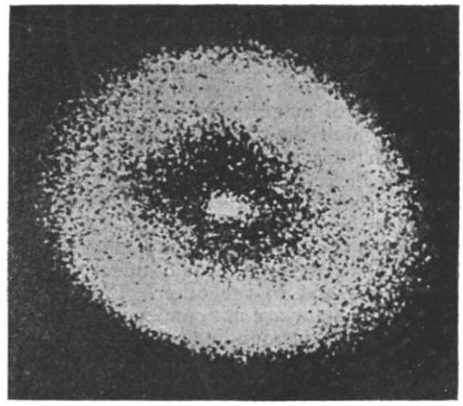

FIG. 3.—The ring nebulæ in Lyra.

does not show us that these things are probably other universes, other systems, like our own. We must consider most of the stars which we see with our most powerful telescopes as belonging to our own system. The number, as we know, increases tremendously as the plane of the Milky Way is approached, and it is possible that as that central plane of the system contains not only stars but nebulæ, it must also contain any number of dark bodies down to the smallest meteorite, and that we may possibly have there a *vera causa* for an extinction of light near the plane of the Milky Way, which is not possible in other parts of the heavens, especially towards the galactic poles. If that be so, the increase of "nebulæ" towards the poles of the Milky Way may simply mean that we see other universes than our own in greater plenty where the conditions for seeing them become more favourable, and that is the reason why towards the poles of the Milky Way we have this overpowering number of apparently nebulous bodies. Of course if that be so, what will turn out will be that most, if not all, of them are not nebulæ at all; they are systems like our own, are clusters of stars with which our own system has absolutely no concern or connection.

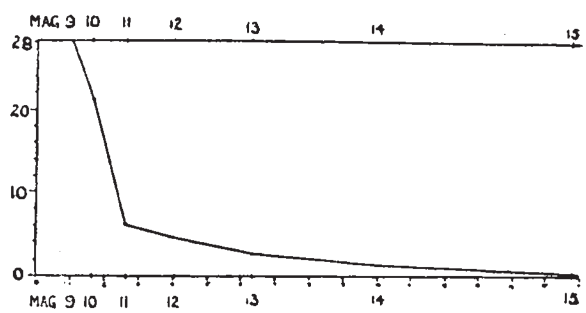

FIG. 4.—Pickering's diagram.

It follows also that the overwhelming number of very faint stars in the Milky Way are stars which would appear brighter if they happened to lie near the galactic poles.

The above suggestion is only an extension of an idea first put forward I believe by Schiaparelli. In spite of the considerable literature on the subject of the extinction

of light in space, it was not till 1889, so far as I can make out, that the possibility of such an extinction being brought about by fine particles of matter was suggested,[1] and he referred to the constitution of comets, falling stars and meteorites in support of this idea.

Now that the nebulæ and stars giving us bright-line spectra, as well as comets and falling stars, have been associated with meteorites, we must expect that the extinction of light, if produced as suggested by Schiaparelli, must very rapidly increase as the Milky Way is approached.

Hence the small magnitude stars in the Milky Way are stars of which the light has been dimmed, and the gap which separates system from system may be gathered from Pickering's diagram (Fig. 4).

We may perhaps, after the recent surveys of space, go a little further than Schiaparelli. A stoppage of light by solid bodies, whether small meteorites or condensed stars like the sun, would affect the spectrum equally from one end to the other. But we now know that many of the stars are not condensed bodies like the sun, and that in the surroundings of these, as well as in the so-called gaseous nebulæ, are gases and vapours which would undoubtedly stop the short more than the long waves of light passing through them; and there is ample evidence, as we have seen, that such stars and nebulæ are more numerous in the plane of the Milky Way than elsewhere. If we take stars of the same chemical species in and away from the Milky Way, and find differences in the lengths of their spectra in the ultra-violet, the inquiry would be carried one stage further.

It is a sure sign of the interest taken in such subjects as these, that, since the above was written, two important contributions to our knowledge have appeared. I hope it may be possible for me to refer to them on a future occasion.

NORMAN LOCKYER.

THE MALARIA CAMPAIGN.

DURING the last two years, no subject has been more discussed in the medical world than paludism, and in the discussion the general public has taken an interest which purely medical matters seldom enjoy. But this is not a matter of only scientific interest, as is readily seen when one hears that five million human lives are the toll India alone pays annually to the grim spectre of malaria.

The prevention of malaria is a problem of great human, political and economic importance, and the Secretary of State for the Colonies, and many wealthy individuals in London and Liverpool, have shown their recognition of this fact by great personal interest and generous contributions of money for the founding of schools of tropical medicine in these two great seaports.

The fact of mosquito agency in the spread of malaria suspected by many, asserted by King (now almost forgotten), Laveran and Manson, and subsequently proved by the brilliant work of Ross, was not accepted at all generally two years ago. Since then, however, expeditions have been to various parts of the world to study the whole question anew.

Two expeditions have been sent to our colonies in West Africa by the Liverpool School of Tropical Medicine, another by the Royal Society to British Central Africa, some members of which subsequently followed the Liverpool men to West Africa, and lastly, in May of this year, at the instance of Dr. Patrick Manson, the London School of Tropical Medicine despatched an expedition, of which more anon, to the Roman Campagna.

[1] "Sulla distribuzione apparente delle Stelle viribili ad occhio nudo."

In addition to these special expeditions sent out from home, Bignami, Celli, Grassi and other well-known Italian observers have been hard at work in their own country, while many medical men of our Colonial service have in their own districts been on the trail of the malaria parasites.

Germany, too, as is her wont, has been equally energetic. The great Koch, at the head of several expeditions, has visited many parts of the world and contributed largely to the sum of our present knowledge. Furthermore, Hamburg, the principal German seaport, has rightly been chosen the seat of a school of tropical medicine, whose objects are identical with those of our own schools and whose head is Prof. Nocht. It is interesting to note that the foundation of this school is due to the initiative of the Imperial Government and the enterprise of the municipal authorities of Hamburg. Save sympathy, our English schools owe nothing to the Government of an empire whose interests are more vitally affected by the problems of tropical medicine than any other in the world.

In the aggregate, the addition to our knowledge from these various sources has been immense. The whole life-history of the Hæmamœbidæ responsible for malaria has been accurately worked out, and a particular genus of mosquito (Anopheles) has been, after due trial, definitely convicted of carrying these parasites from man to man and of acting as definitive host to the parasite during its sexual phase of development. On the other hand, man, the intermediate host in this cycle of alternation of generations, has been proved equally necessary for the propagation of the species. A constant association therefore of man with mosquito seems the rule in a vicious circle, which keeps up the supply of parasites and precludes the possibility of their destruction and extinction.

One day, however, it may be shown that the human Hæmamœbidæ can complete their asexual cycle in some mammal other than man. But as yet there is no evidence of this, and Koch has stated his disbelief in the existence of any second alternative host.

As soon as there was a fair presumption (if not positive proof) that the parasites of malaria multiplied by a process of alternation of generation, in which man and a mosquito played the leading parts as intermediate and definitive hosts respectively, all workers in the subject turned their attention to the identity of the species of mosquito concerned, their habits and bionomics, and to the best method of applying practically their newly-found knowledge with a view to reducing the ravages of the fever.

New species of Anopheles were met with, and statistics of health and meteorological observations collected, with the result that our knowledge of mosquito life generally, and especially its relation to malaria, has greatly increased. Major Giles, in his recent monograph on "Mosquitoes," has collected and arranged many of the new facts, but even now we do not know how many varieties of Anopheles there are nor are we certain if all species of this genus are hospitable to the malaria parasites.

In a report recently issued by the trustees of the British Museum, Mr. F. V. Theobald gives us much further information about the Culicidæ, their distribution in nature and some points to help in the identification of species. From this report we learn that twenty-two species of Anopheles are now known, and of these ten are entirely new to science, while of Culex some ninety new species have been described.

It would appear that as a genus Anopheles is worldwide in its distribution, but is more limited in regard to species. This pamphlet is a valuable contribution to knowledge, and is evidence of the magnitude of the work now being done to increase our meagre knowledge of the Culicidæ and gives a good idea of the special difficulties of the subject.